

May 25, 2006

DECLARATION

The undersigned, Dana Scruggs, having an office at 8902B Otis Avenue, Suite 204B, Indianapolis, Indiana 46216, hereby states that she is well acquainted with both the English and German languages and that the attached is a true translation to the best of her knowledge and ability of PCT/EP 2005/050446 (INV.: GENTER, G., ET AL).

The undersigned further declares that the above statement is true; and further, that this statement was made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or document or any patent resulting therefrom.

A handwritten signature in black ink, appearing to read "Dana Scruggs", with a long horizontal flourish extending to the right.

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Dana Scruggs

## ECCENTRIC GEARING

### Background Information

The present invention relates to eccentric gearing for displacing two parts positioned in  
5 a manner that enables them to move relative to one another, according to the general  
class of independent Claim 1.

Publication EP 0 981 696 B1 makes known an electric motor with an eccentric gearing  
system, with which an eccentric gear mounted on an eccentric is located on a bolt  
integrated in the motor housing. The drive for the eccentric is an electric motor that is  
10 either electrically commutated or has brushes, and is located directly in the housing of  
the eccentric gearing system. A driving element connected with the eccentric is  
designed integral with the armature of the electric motor, the armature also being  
rotatably mounted on the bolt. The eccentric gear includes guide elements that are  
guided either directly in the stationary housing cover in an opening serving as a guide,  
15 or they are guided into openings located in a sliding piece which is accommodated in a  
housing cover and is displaceably guided therein.

A device of this type has the disadvantage that, when high levels of torque are produced  
and act on the output element, e.g., when strong displacement forces are produced or if  
a crash occurs, the eccentric gear and the gearing housing can become damaged  
20 quickly. A gearing device of this type is therefore not suited for use in adjustment  
applications in the motor vehicle, e.g., seat adjustments, on which high safety  
requirements are placed.

### Advantages of the Invention

25 The eccentric gearing according to the present invention having the characterizing  
features of independent Claim 1 has the advantage that, by locating a stable fastening  
flange around a coupling element that interacts with the eccentric gear, it is possible to

redirect torques that act on the output element to chassis-mounted parts via the fastening flange. As a result of the frictional connection of the output element via the eccentric gear directly with the coupling element and, via this, directly with the fastening flange, the rotary drive with its force-transmission path to the driving element of the eccentric is protected against excessive force. The gearing housing is also protected  
5 against excessive power flow, which means it can be advantageously made of plastic.

Due to the measures listed in the subclaims, advantageous refinements and improvements of the features indicated in Claim 1 are made possible. If the fastening flange includes recesses which are designed, e.g., as openings in the flange, the  
10 gearing housing parts can be fastened to it, and the entire eccentric gearing can be fastened to one of the parts which move relative to each other.

If the fastening flange is made of metal, e.g., steel, it can transmit particularly high forces without the gearing being destroyed. In addition, radial flaps can be favorably integrally formed thereon, the radial flaps including recesses used for fastening to one of  
15 the parts which move relative to each other.

If the gearing housing is made of plastic, additional gearing elements can be mounted therein directly, with minimal friction. Due to the design of an axially installable gearing housing cover, the two housing parts can be advantageously fixed to the stably designed fastening flange.

20 In order to radially center the body and cover of the gearing housing relative to each other and to the remaining gearing components during assembly of the gearing, the fastening flange includes at least one collar with a radial support surface, against which the housing parts bear radially.

To force the eccentric gear to make an eccentric motion around the central housing axis, guide elements are located on the coupling element, the guide elements  
25 interacting with the eccentric gear and the fastening flange such that the coupling element is guided along a line without rotating.

To this end, the fastening flange includes radially oriented projections that interact with

radially oriented counter-elements, e.g., open elongated holes, of the coupling element.

In addition, the coupling element includes further radially oriented guide elements which are oriented nearly perpendicularly to the first guide rails and interact with corresponding counter-elements of the eccentric gear.

- 5 To transfer high torques which act on the eccentric gearing, the fastening flange includes support surfaces, against which corresponding support surfaces of the coupling element bear, in order to transfer the torque in both directions. Particularly favorably, the guide surfaces of the guide elements can serve simultaneously as support surfaces.

- 10 To achieve a compact design of the eccentric gearing, and in particular to attain a small outer diameter, the eccentric gear has external toothing which meshes with corresponding internal toothing – which has a different number of teeth – of the output element.

- 15 To achieve a small outer diameter of the gearing, a bolt – as an extension of the output element – is designed as the central axis, the individual gearing elements being located on the bolt. To realize a further reduction stage, the driving element can be driven via a wormwheel by a worm shaft of an electric motor.

- 20 To absorb the forces acting on the output element, the output element is mounted radially and/or axially in the cover of the gearing housing. To this end, the cover of the gearing housing is preferably made of metal. A portion of the output element extends out of an opening of the cover and forms an interface – which can have any shape – with the adjustment mechanisms of the part to be adjusted and/or the part attached to the housing.

## Drawing

- 25 Various exemplary embodiments of a device according to the present invention are presented in the drawing and are described in greater detail in the description below.

Figure 1 shows a cross section through an eccentric gearing, according to the

present invention, through A – A, and

Figure 2 shows a radial cross section of the eccentric gearing through II – II.

#### Detailed Description of the Exemplary Embodiments

5 Figure 1 shows eccentric gearing 10 with a gearing housing 12 that includes a body 14 made of plastic and a cover 16, which is made, e.g., of metal. A bolt 18 is located in gearing housing 12, on which an eccentric element 20 is rotatably mounted. Eccentric element 20 is rotatably connected with a worm gear 22, which meshes with a worm 24. Worm 24 is located, e.g., on an armature shaft 26 of a not-shown electric motor 28  
10 which causes eccentric element 20 to rotate around support bolt 18. In a further, not-shown exemplary embodiment, eccentric element 20 is driven directly by an armature of electric motor 28, as shown, e.g., in EP 0 981 696 B1.

An eccentric gear 30 with spur gearing 34 designed as external toothing 32 is mounted on eccentric element 20, eccentric gear 30 being supported such that it can rotate freely  
15 around eccentric element 20. External toothing 32 meshes with internal toothing 36 of a ring gear 38 which is designed as an output element 40. To transmit the output torque to not-shown kinematics of a seat frame, output element 40 has, e.g., groove toothing 42, serration 43, or an inner polyhedron 44, with which a force-transmission element 9 of seat linkage meshes in a form-fit manner. Eccentric element 20 and output element  
20 40 with internal gear 38 are located axially one above the other on support bolt 18.

Output element 40 is mounted non-rotatably and eccentric element 20 is mounted rotatably on support bolt 18, for example, support bolt 18 being rotatably mounted in gearing housing 12. Output element 40 bears radially via a radial outer surface 46 against a circular opening 48 of cover 16. In addition, cover 16 has an axial shoulder 50,  
25 against which output element 40 and, via this, driving element 20 and eccentric gear 30 bear axially. If cover 16 is made, e.g., of steel, a bearing bush 52 is located between output element 40 and cover 16, bearing bush 52 being made, e.g., of plastic, in order to support the eccentric gearing with reduced friction. The number of teeth 35 in internal toothing of ring gear 38 differs from the number of teeth in external toothing 32 of

eccentric gear 30, by way of which a differing reduction ratio can be realized. Eccentric gear 30 is guided by eccentric element 20 and is prevented from rotating by a coupling element 54. To this end, coupling element 54 includes first guide elements 56 which engage in corresponding counter-elements 57 of a fastening flange 60 located between  
 5 body 14 and cover 16. As a result, coupling element 54 is capable of being moved relative to fastening flange 60 only along a line 62. To couple fastening flange 60 with eccentric gear 30, coupling element 54 includes second guide elements 64 which interact with corresponding counter-elements 65 of eccentric gear 30. Guide and counter-elements 54, 30 are designed such that eccentric gear 30 can also move –  
 10 relative to coupling element 54 – exclusively along a second line 66, which is located approximately perpendicular to line 62. Since eccentric gear 30 can now move – relative to fastening flange 60 – only along two lines 62, 66 positioned nearly perpendicularly to each other, eccentric gear 30 is prevented from rotating by coupling element 54. As a result, output element 40 walks around eccentric gear 30 in accordance with the  
 15 reduction ratio.

In the exemplary embodiment, as shown in the cross section in Figure 2, fastening flange 60 includes radial segments 68, as first counter-elements 57, which engage in radial recesses 70 that form first guide elements 56. Coupling element 54 is guided along lateral guide surfaces 72 of first guide elements 56 along corresponding lateral  
 20 counter-guide surfaces 73 of fastening flange 60. Simultaneously, guide and counter-guide surfaces 72, 73 serve as support shoulders 75, via which torque is transmitted between coupling element 54 and fastening flange 60. Second guide elements 64 of coupling element 54 are designed as second radial recesses 78, into which guide bolts 80 designed as second counter-guides 65 engage. Radial recesses 78 include both  
 25 guide surfaces 82, against which guide bolts 80 bear via counter-guide surfaces 84 and force eccentric gear 30 to move relative to coupling element 54 along line 66. Second guide and counter-guide surfaces 82, 84 are also designed as second support shoulders 85, via which torque is transmitted between eccentric gear 30 and coupling element 54. Coupling element 54 includes a central, e.g., circular opening 86. Eccentric  
 30 element 20, which penetrates opening 86, can rotate around central axis 19 inside opening 86. In this case, the exterior shape of coupling element 54 is designed nearly

circular in shape, and its outer diameter 88 is smaller than the inner diameter 90 of the nearly circular recess 67 of fastening flange 60, in order to enable displacement of coupling element 54 along axis 62. First guide elements 56 and second guide elements 64 of coupling element 54 are designed as recesses 70, 78 which open radially  
 5 outwardly or radially inwardly toward opening 86. In alternative designs, recesses 70, 78 can also be designed as closed elongated holes or tangential parallel guide surfaces, depending on the shape of guide elements 56, 64 and counter-elements 57, 65.

Fastening flange 60 encircles entire coupling element 54, which is located inside recess 67. Coupling element 54 is located at the same axial level as fastening flange 60 in a  
 10 plane perpendicular to support bolt 18. Recesses 94 for connecting elements 99, e.g., screws or rivets, are formed in an outer edge region 92 of fastening flange 60, via which cover 16 and body 14 are connected with each other and/or with fastening flange 60. To this end, screws 99 are located, e.g., in corresponding counter-recesses 96 of cover 16, screws 99 penetrating recesses 94 designed as holes and being screwed into body 14.

15 Gearing housing 12 is therefore tightly closed and fastening flange 60 is integrated in gearing housing 12. As a result, one of the housing parts 14 or 16 bears against an axial side 59, 61 of fastening flange 60. Fastening flange 60 includes further projections 100 which extend beyond the gearing housing, and recesses 95 for fastening elements 99 which connect fastening flange 60 with one of the parts 8, 9 which are movable  
 20 relative to each other. Recesses 95 are also designed, e.g., as round holes 98 that accommodate, e.g., screws 99 or rivets 99. Spacers 102 are located on recesses 95 in order to position eccentric gearing 10 relative to one of the parts 8, 9 which are movable relative to each other. Fastening flange 60, which is produced, e.g., as a stamped sheet metal part, has a hole 104 in its interior region, by way of which a radial inner surface  
 25 106 and a radial outer surface 108 are formed. As a result, fastening flange 60 serves as a centering element for housing parts 14 and 16, cover 16 bearing against radial inner wall 106 with an outer edge 107, and body 14 bearing against radial outer wall 108 with a recess 109. In addition to this radial fixation, fastening flange 60 includes further recesses 111 as rotation-prevention elements 110, in which form-fit counter-  
 30 elements 112 of cover 16 engage.

In an application for seat adjustment, according to the present invention, eccentric gearing 10 is connected via recesses 95 of fastening flange 60 with a seat frame 8, 9, output element 40 being operatively connected via interface 42, 43, 44 with a part 8, 9 which is movable relative to the seat frame, e.g., the seat back. If high levels of torque  
 5 now act on output element 40 when the vehicle is struck from behind, they are transmitted by eccentric gear 30 via support shoulders 85 to coupling element 54, and, from this, via support shoulders 75 directly to fastening flange 60, and are therefore absorbed by the seat frame. As a result, electric motor 28 and first gear stage (worm 24, worm gear 22 and gearing housing 12) are not subjected to excessive force.

10 In a not-shown, alternative exemplary embodiment, coupling element 54 is designed integral with eccentric gear 30. Coupling element 54 has external toothing that engages directly with internal toothing of fastening flange 60. Eccentric gear 30 with coupling element 54 is located such that it can rotate freely, the reduction resulting from the ratio of the tooth pairing of coupling element 54 with fastening flange 60 to the tooth pairing  
 15 of internal toothing 36 / external toothing 32. In this case as well, the high crash torques introduced via output element 40 are transmitted via the external toothing of coupling element 54 directly to the internal toothing of fastening flange 40 and, therefore, to the seat frame. The external toothing of coupling element 54 can be designed to be continuous with the external toothing 32 of eccentric gear 30, or it can be designed as  
 20 offset toothing.

It should be noted that, with regard for the exemplary embodiments presented in the figures and the description, many different combinations of the individual features are possible. For example, the specific embodiment of fastening flange 60, coupling element 54 and eccentric gear 30 with first and second guide elements 56, 64 with  
 25 corresponding counter-elements 57, 65 or the angle between the two lines 62 and 66 can be varied in any manner possible. The important aspect is that it be possible for high torques acting on eccentric gearing 10 to be directed away via a form-fit connection of coupling element 54 with fastening flange 60 via fastening flange 60, which is designed to have load-bearing capacity. As a result, housing 12 and the other  
 30 components that are not located in the power flow can be made of lower-cost materials



optimized for use for gearing, such as plastic. The application of eccentric gearing 10 is not limited to adjusting seat parts in a motor vehicle. Instead, it can be used with any adjustment devices with which high torques need to be absorbed.